



MARCH 20, 2014 ■ SHANGHAI, CHINA

GSA

GLOBAL LEADERSHIP SUMMIT

GAME CHANGERS



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GSA

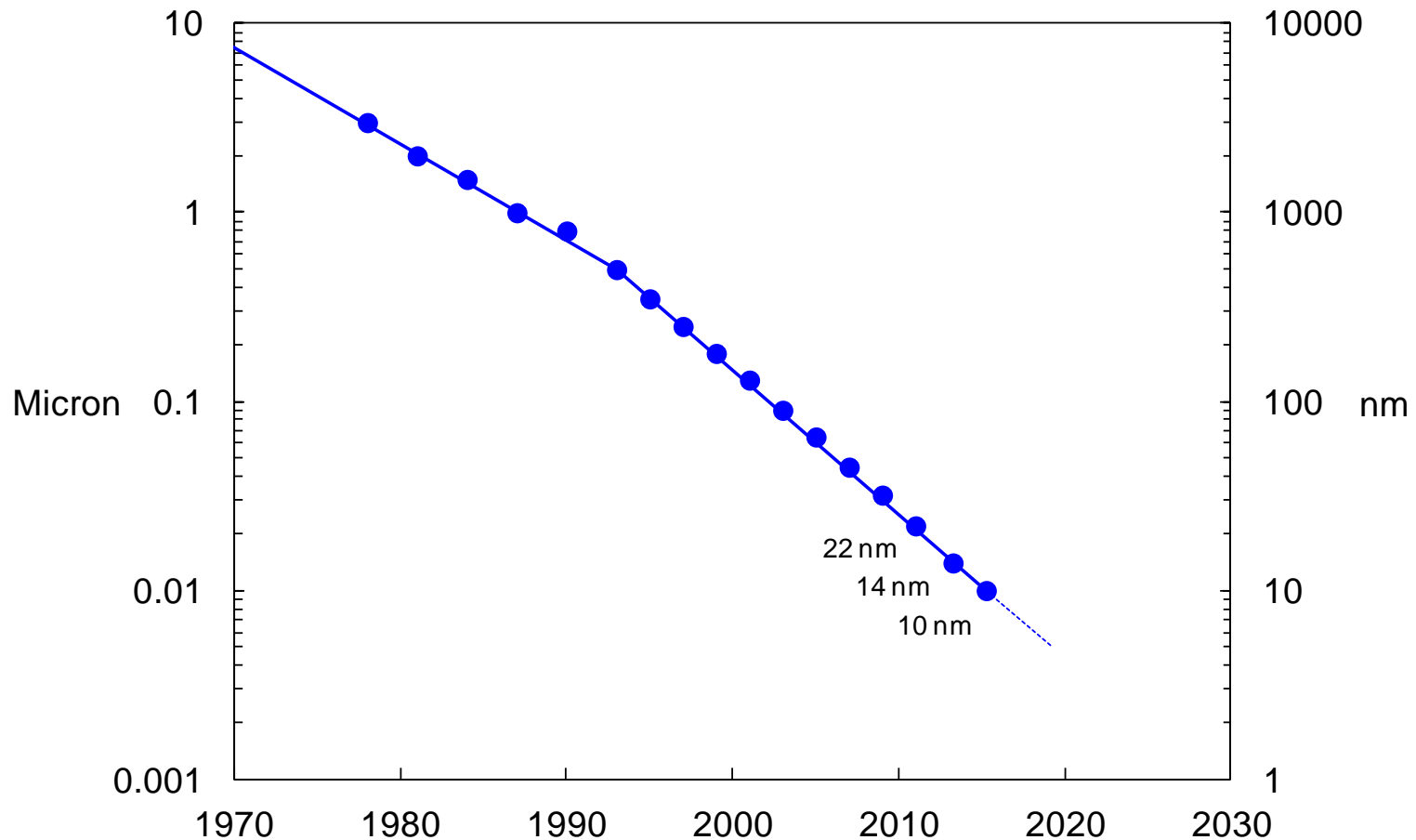
GLOBAL LEADERSHIP SUMMIT

GAME CHANGERS

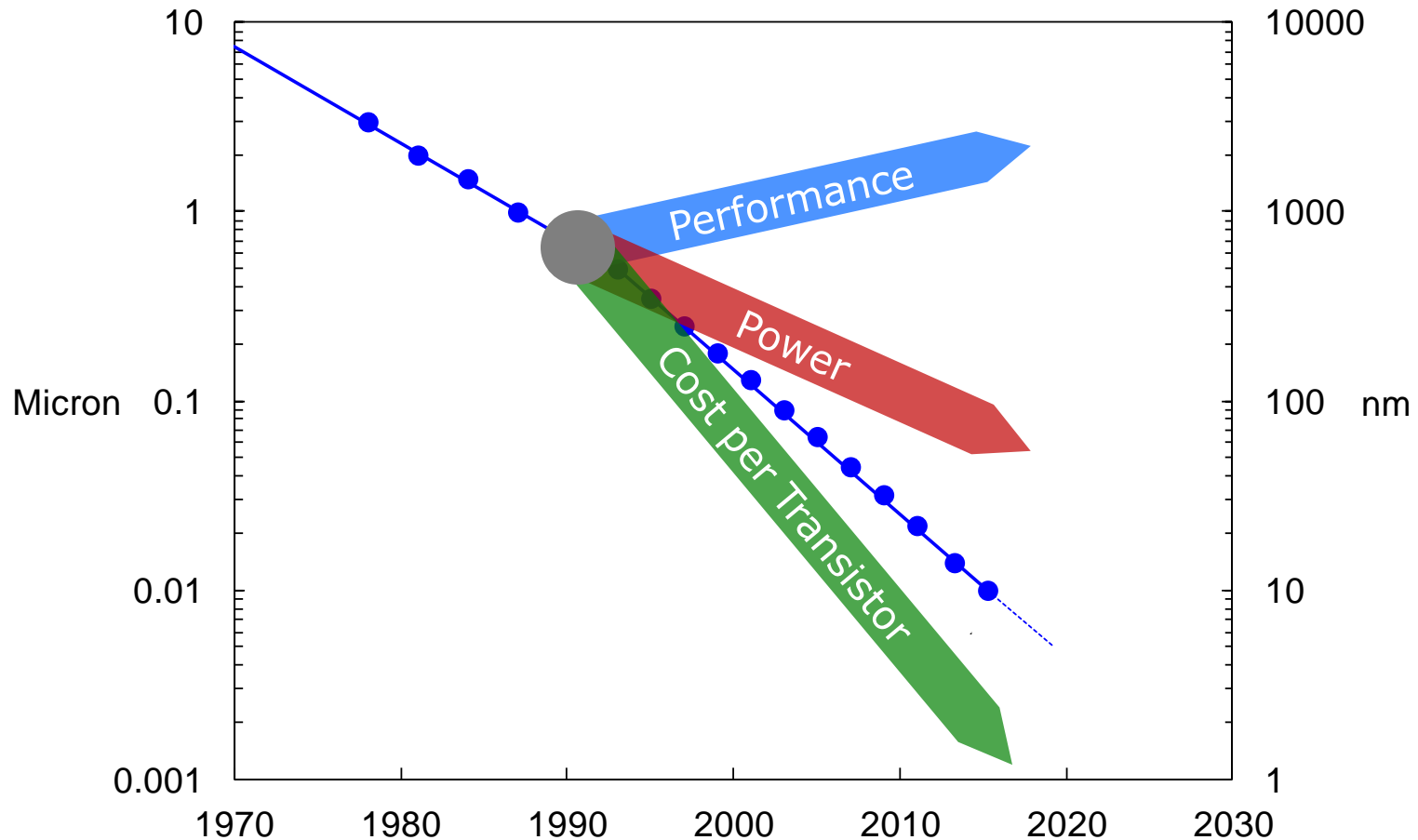
Moore's Law: Alive and Well

Mark Bohr
Intel Senior Fellow

Intel Scaling Trend

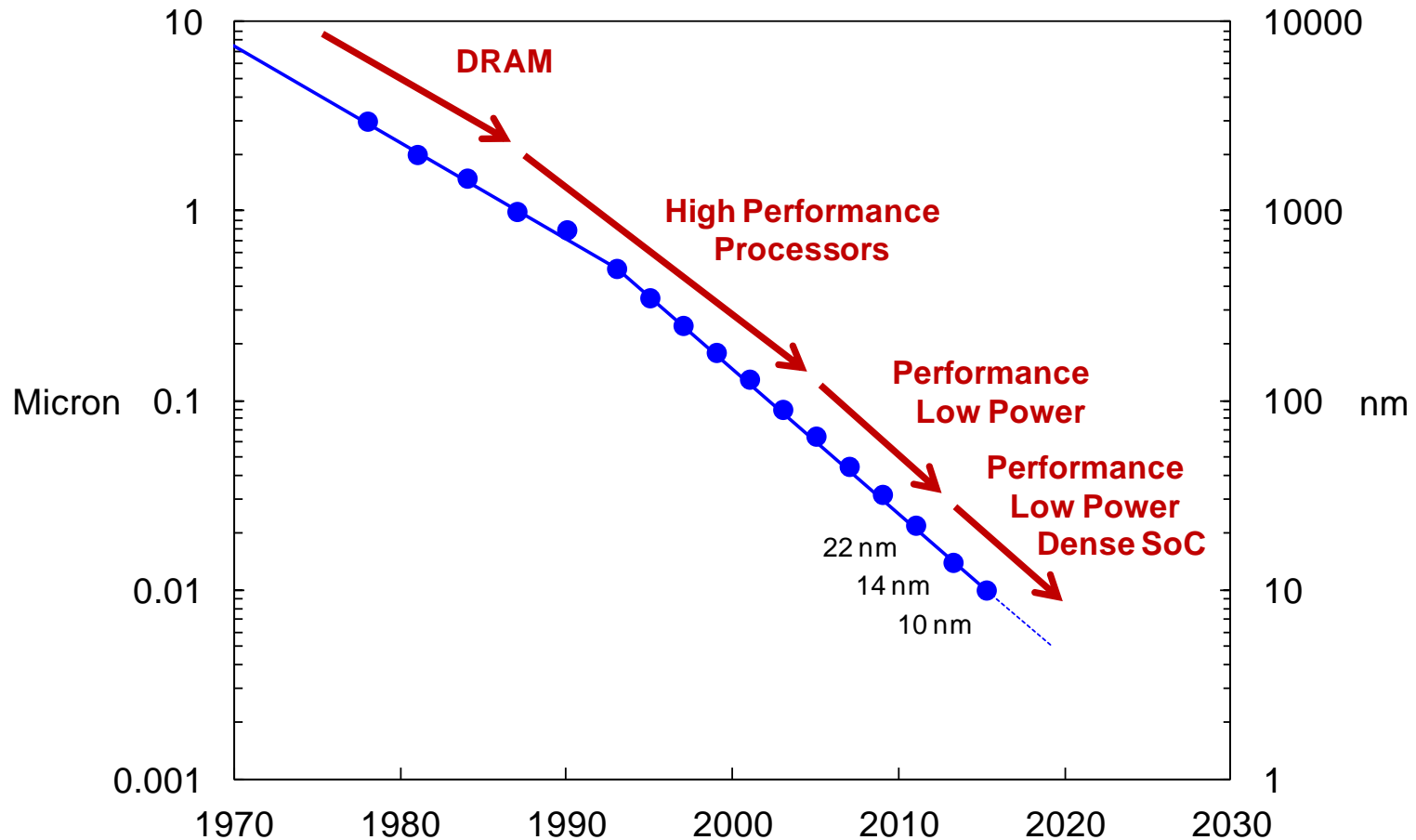


Intel Scaling Trend



Dimensions scale to provide improved performance,
lower power and lower cost per transistor

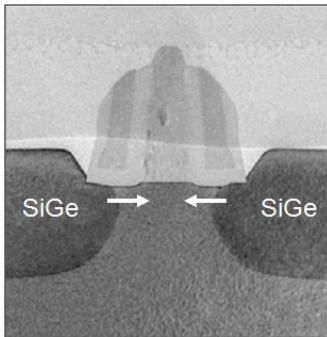
Inflection Points



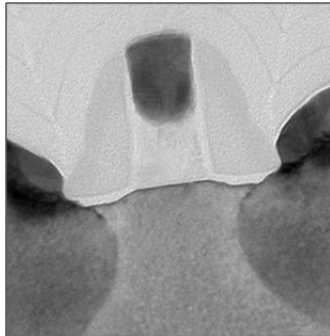
Product markets change, and thus the goals of scaling change

Transistor Evolution

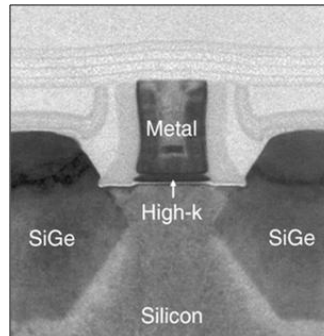
90 nm
2003



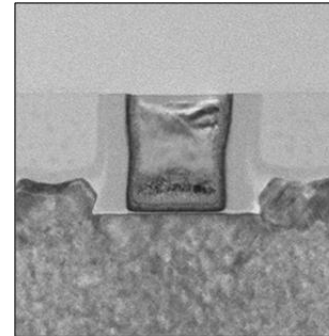
65 nm
2005



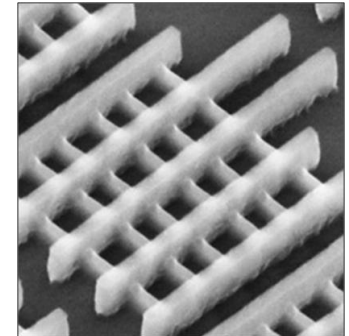
45 nm
2007



32 nm
2009



22 nm
2011



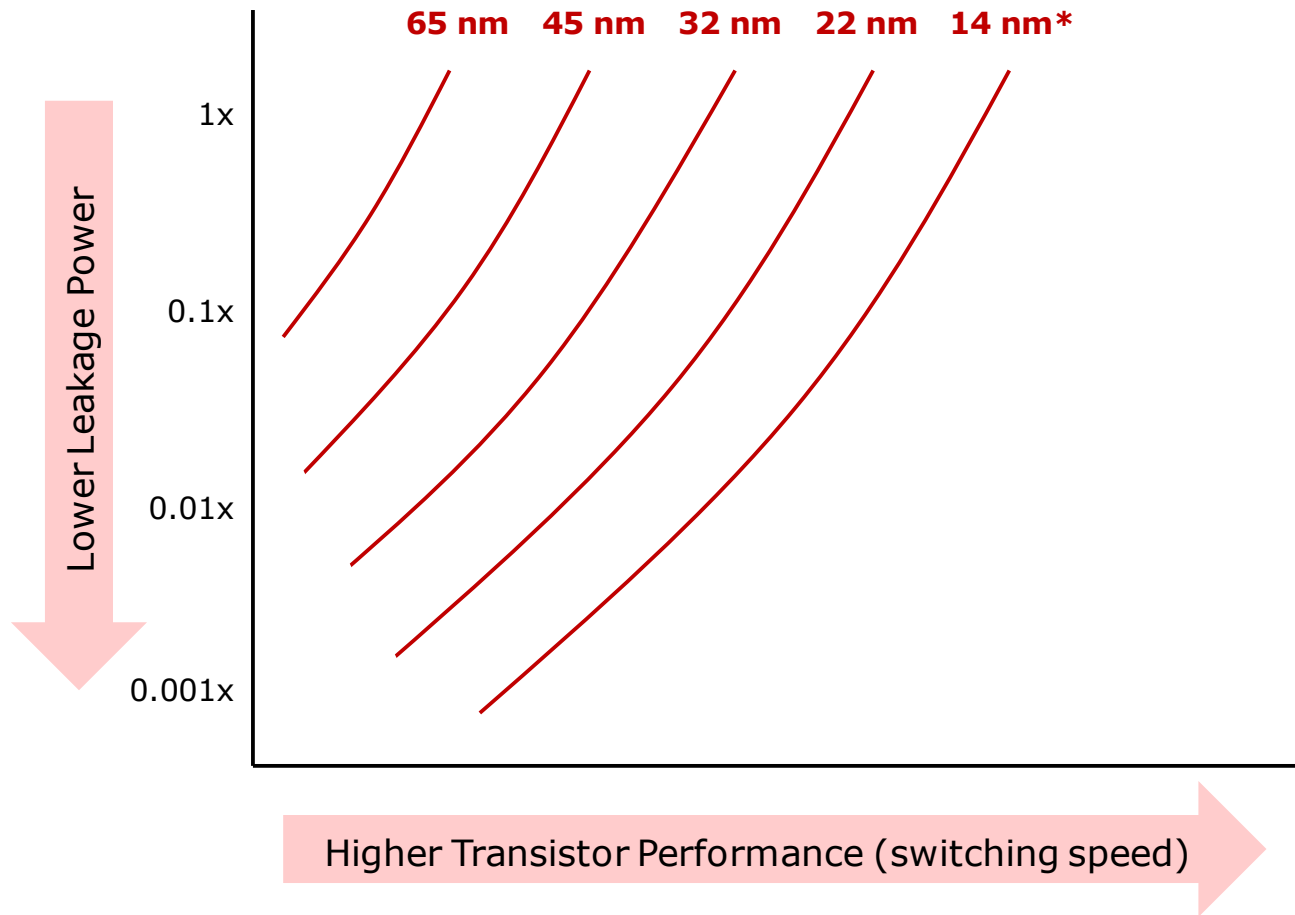
SiGe Strained Silicon

High-k Metal Gate

Tri-Gate

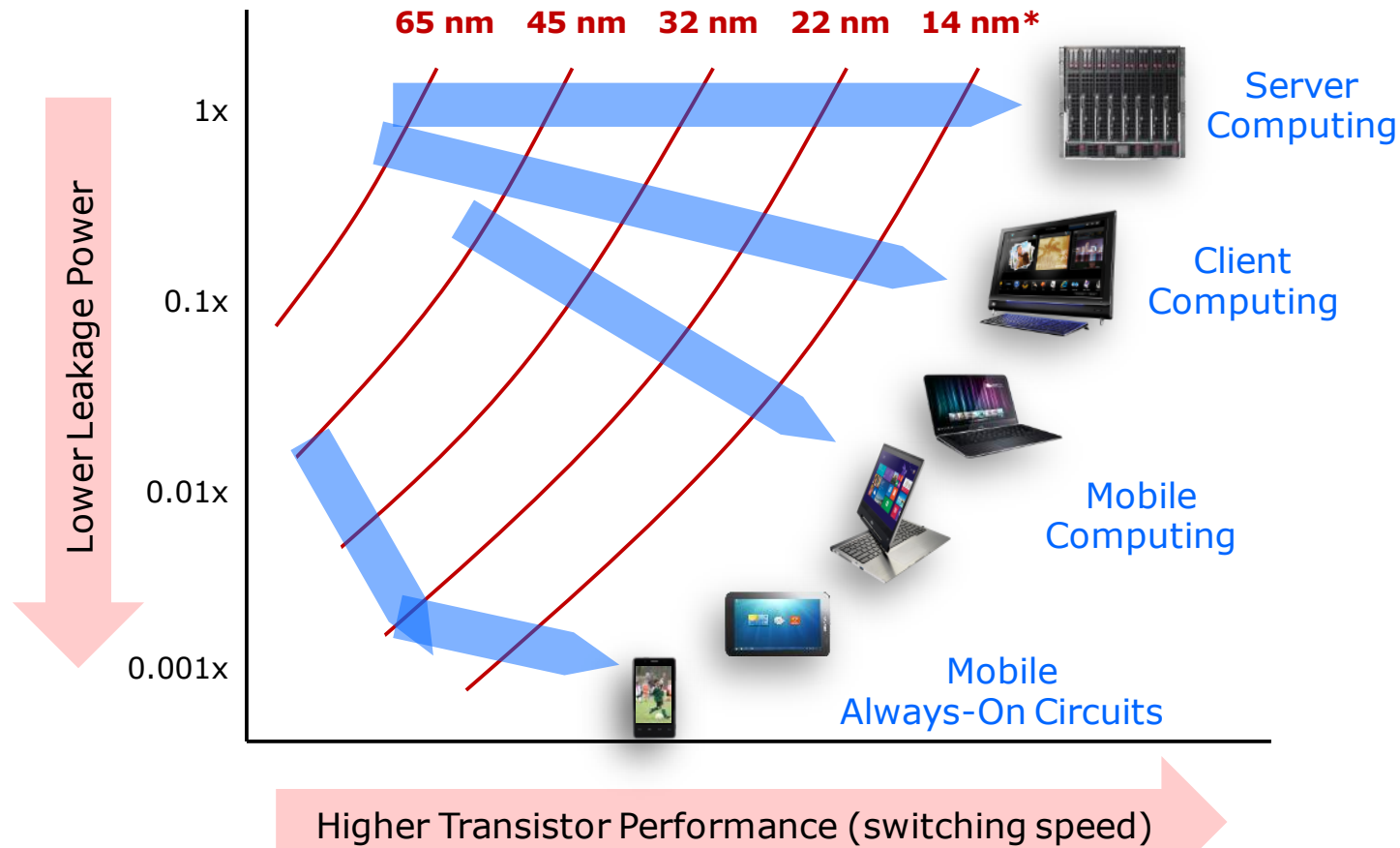
Innovations in both device materials and device structures are now needed to continue scaling

The Value of Better Transistors



Source: Intel
* Forecast

The Value of Better Transistors

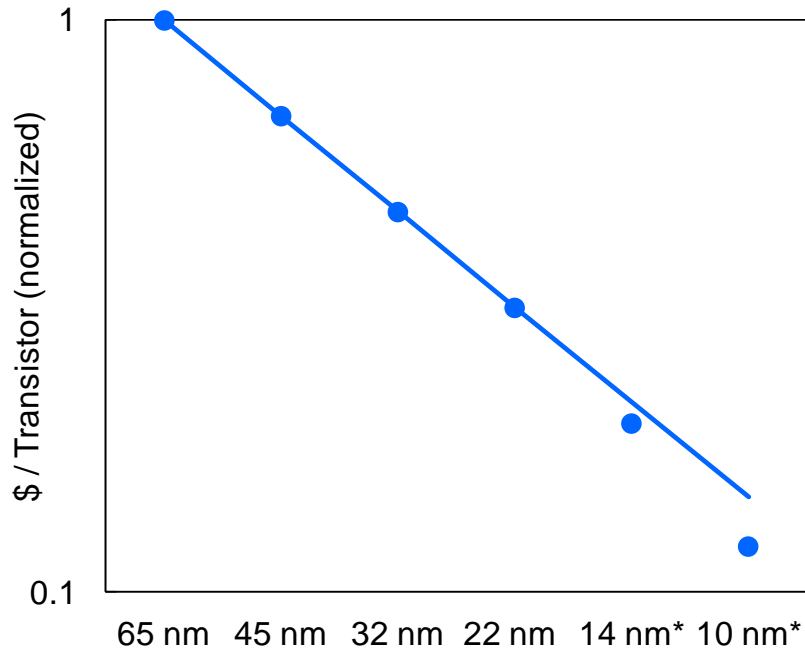


The same fundamental improvement benefits a wide range of products

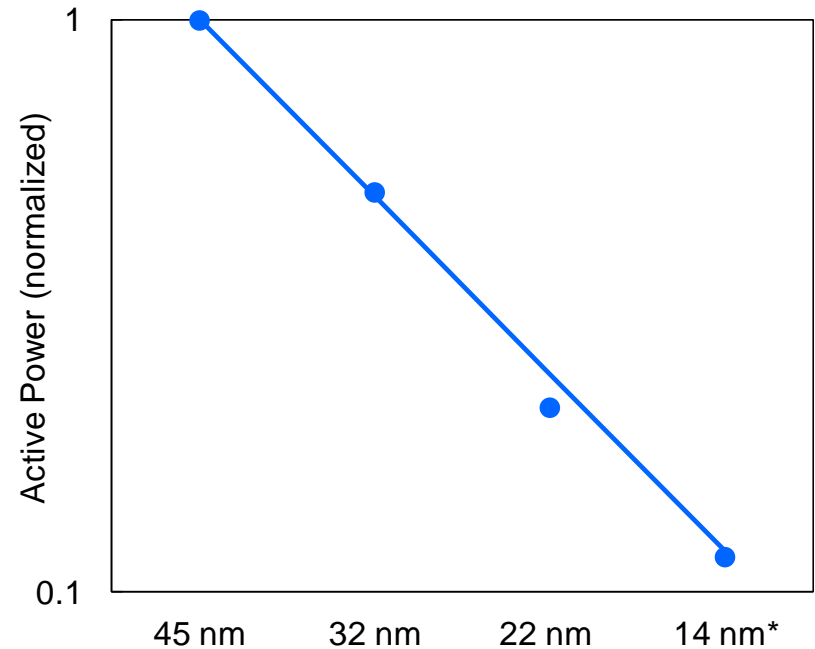
Source: Intel
* Forecast

Getting the Benefits of Moore's Law

Lower Cost per Transistor

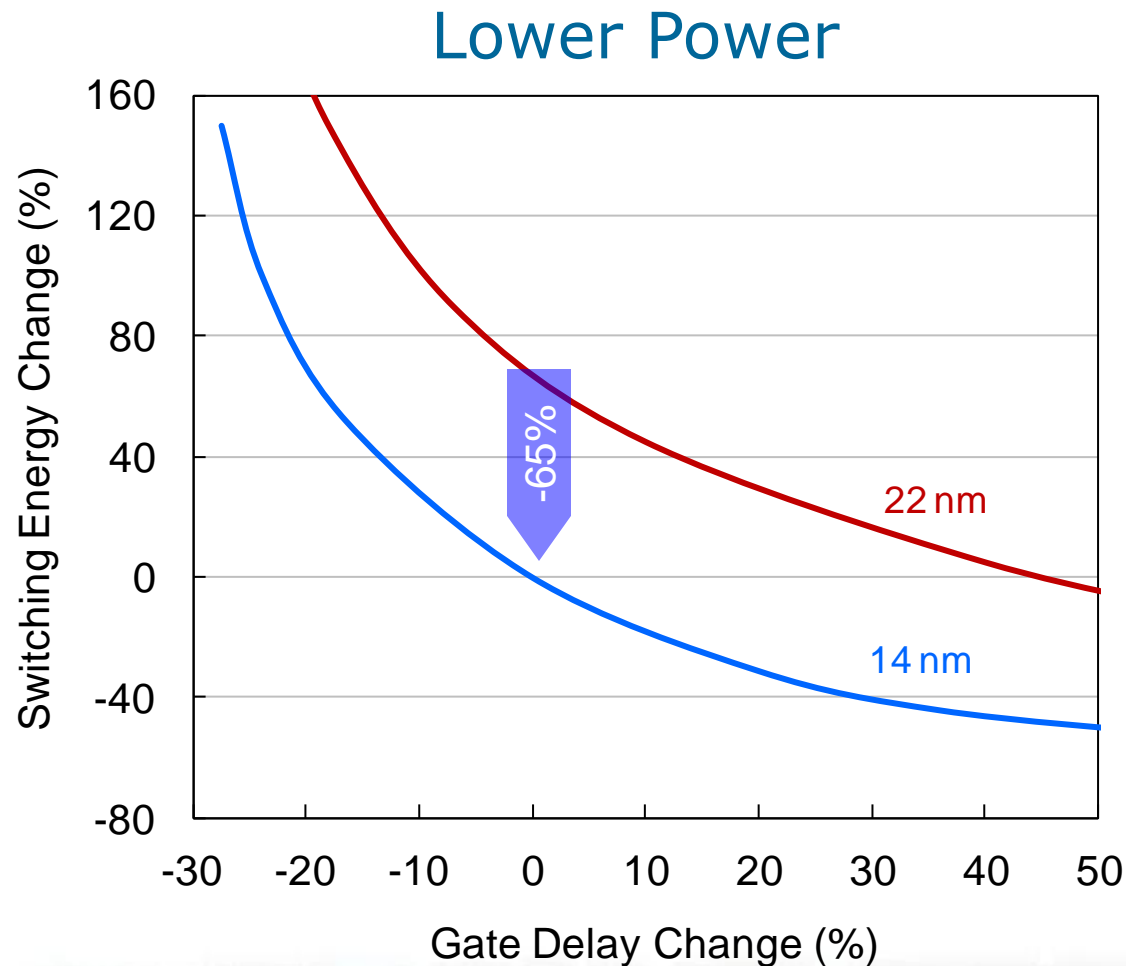


Lower Active Power

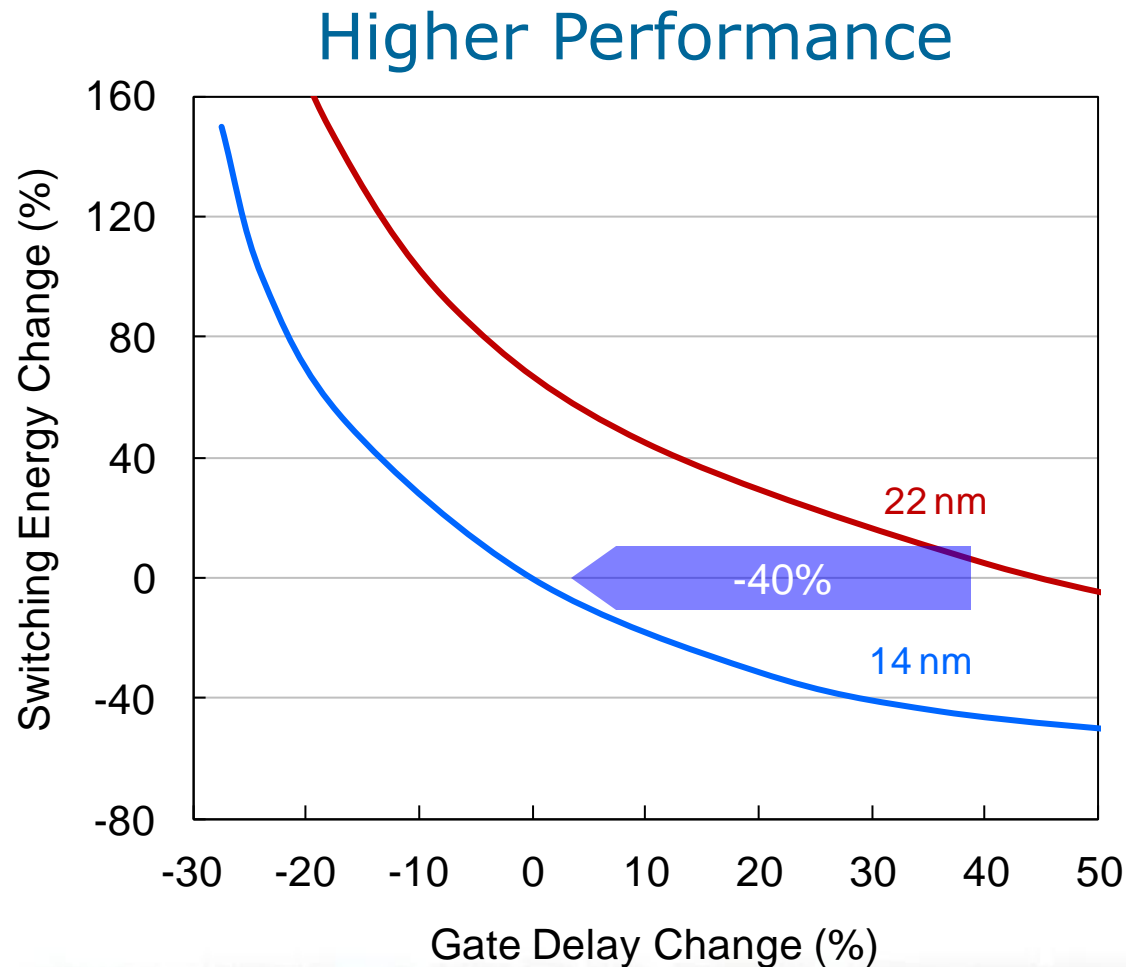


Source: Intel
* Forecast

Getting the Benefits of Moore's Law

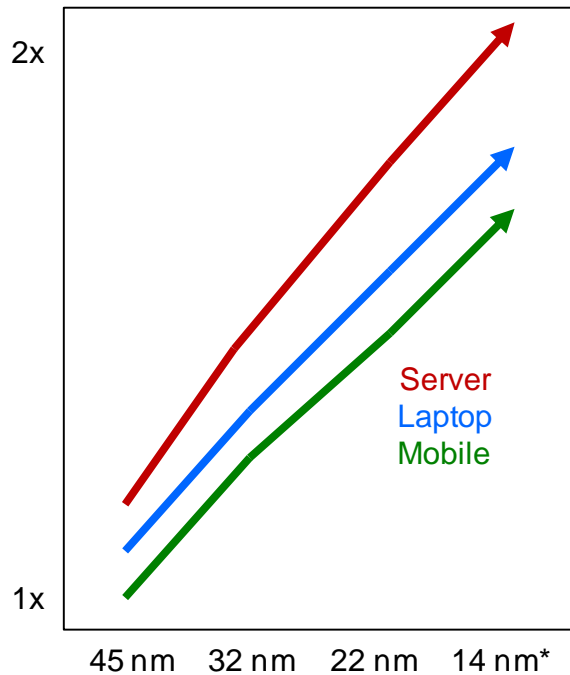


Getting the Benefits of Moore's Law



Benefits Across all Product Families

Performance

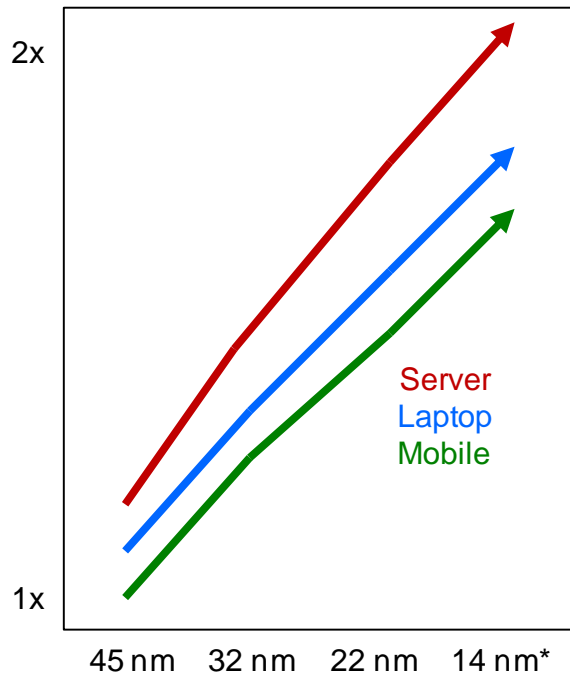


Performance improved
for all product families

Source: Intel
* Forecast

Benefits Across all Product Families

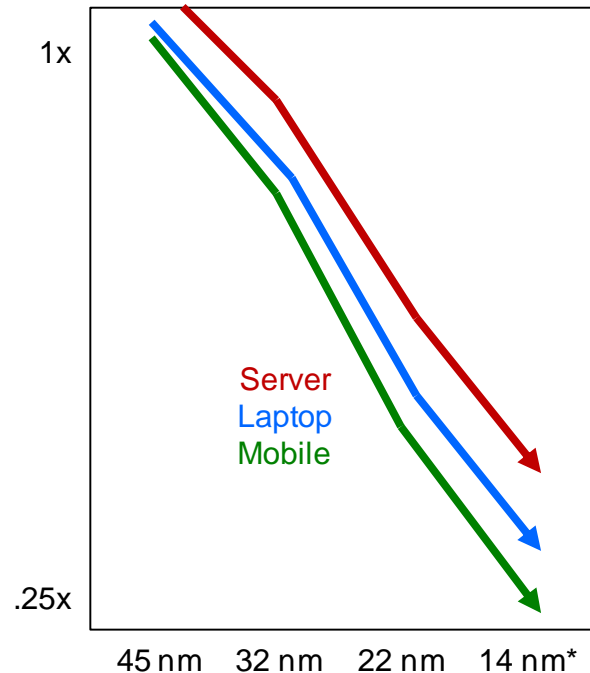
Performance



Performance improved
for all product families

Active Power

(Includes performance increase)

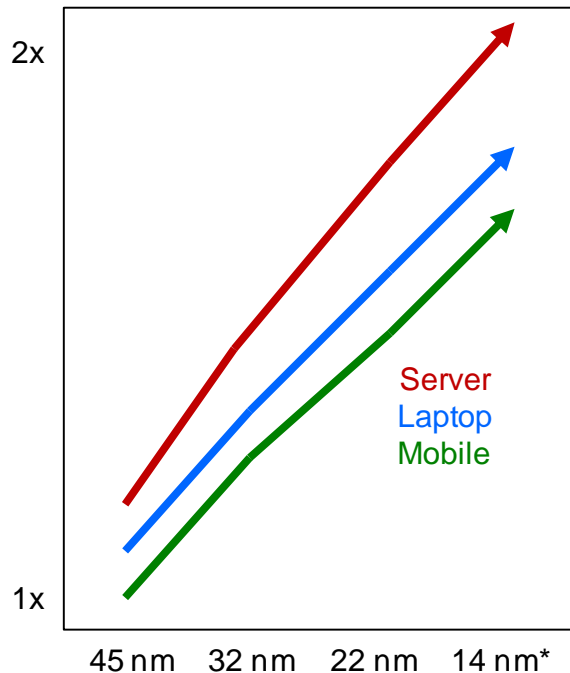


Active power reduced
for all product families

Source: Intel
* Forecast

Benefits Across all Product Families

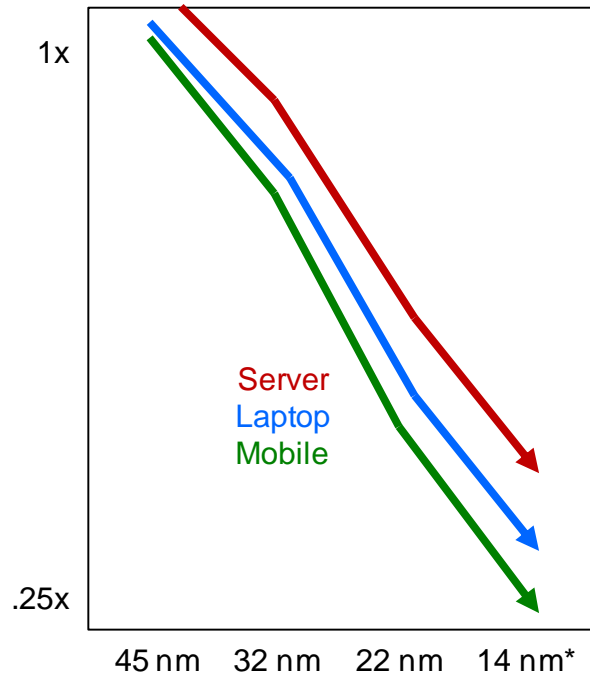
Performance



Performance improved
for all product families

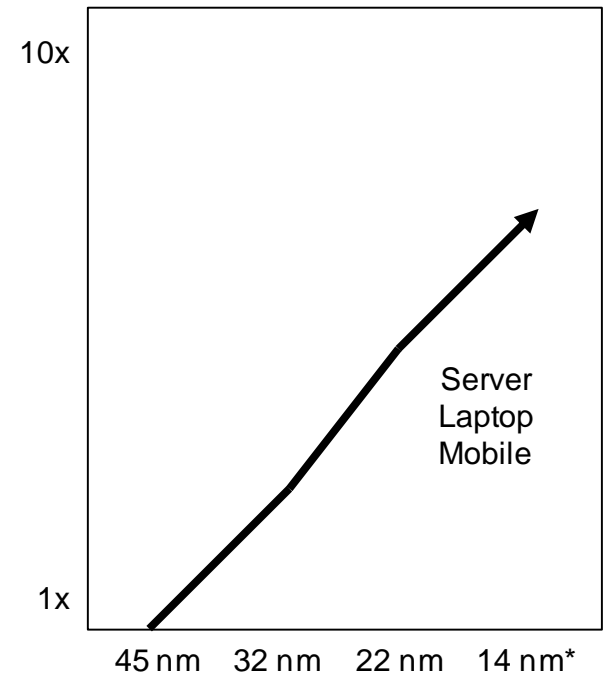
Active Power

(Includes performance increase)



Active power reduced
for all product families

Performance per Watt

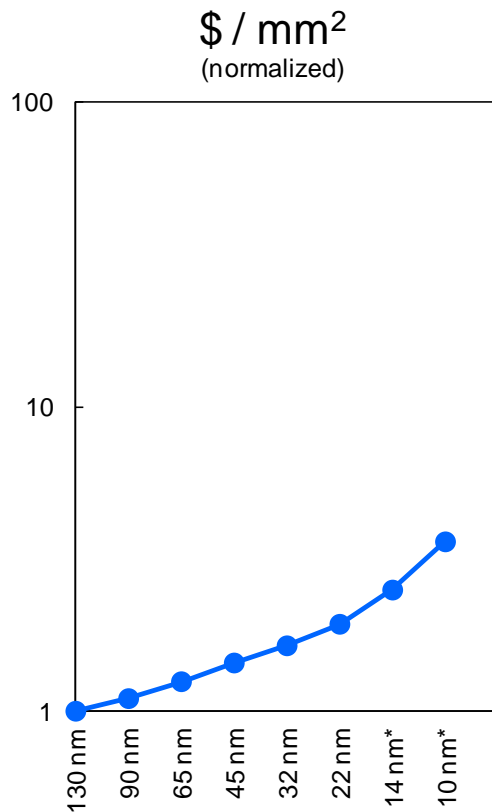


Performance per watt improves
>1.6x per generation

Improved performance per watt is the critical enabler for all

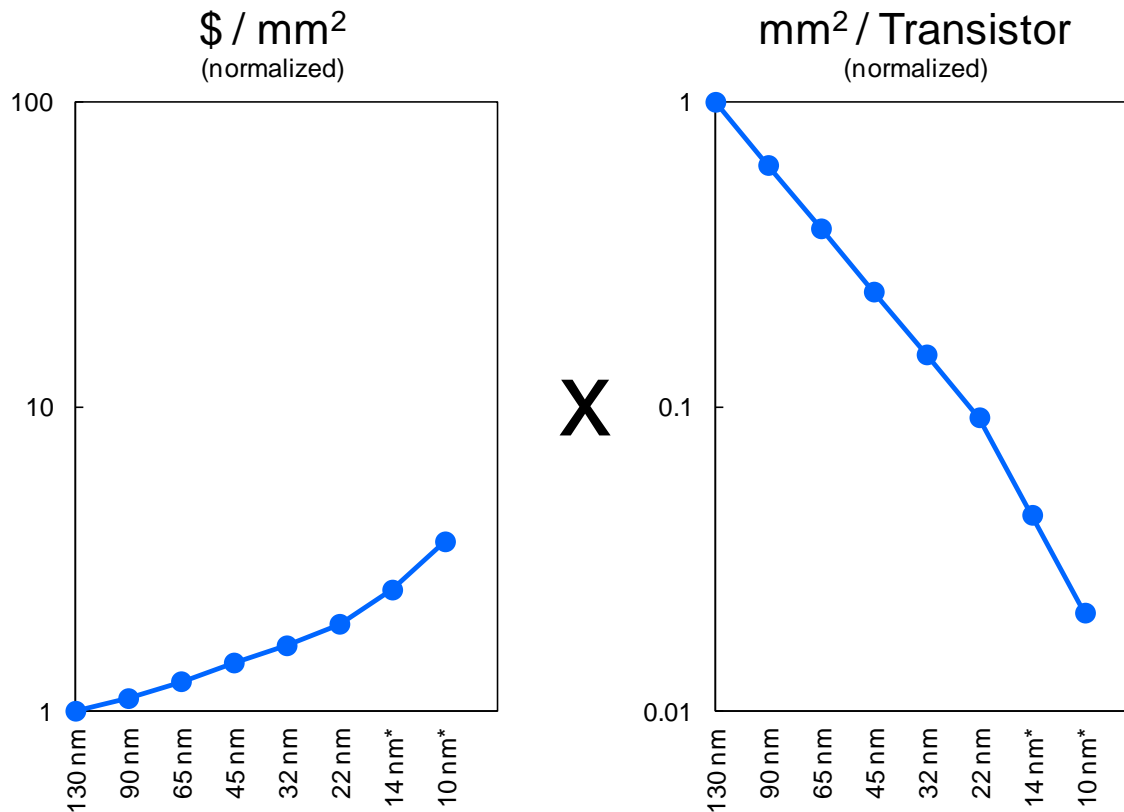
Source: Intel
* Forecast

Density Improvements Offset Wafer Cost Trend



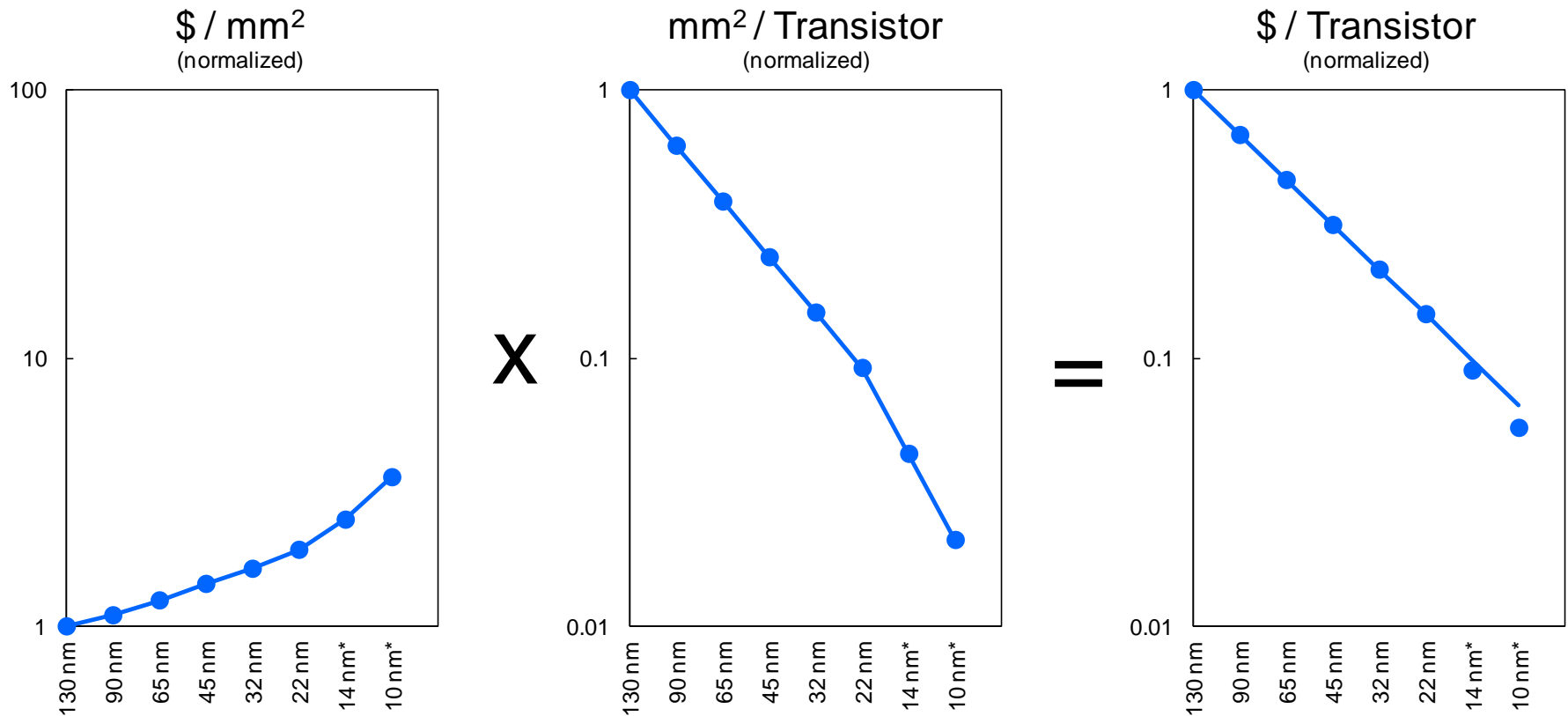
Source: Intel
* Forecast

Density Improvements Offset Wafer Cost Trend



Source: Intel
* Forecast

Density Improvements Offset Wafer Cost Trend

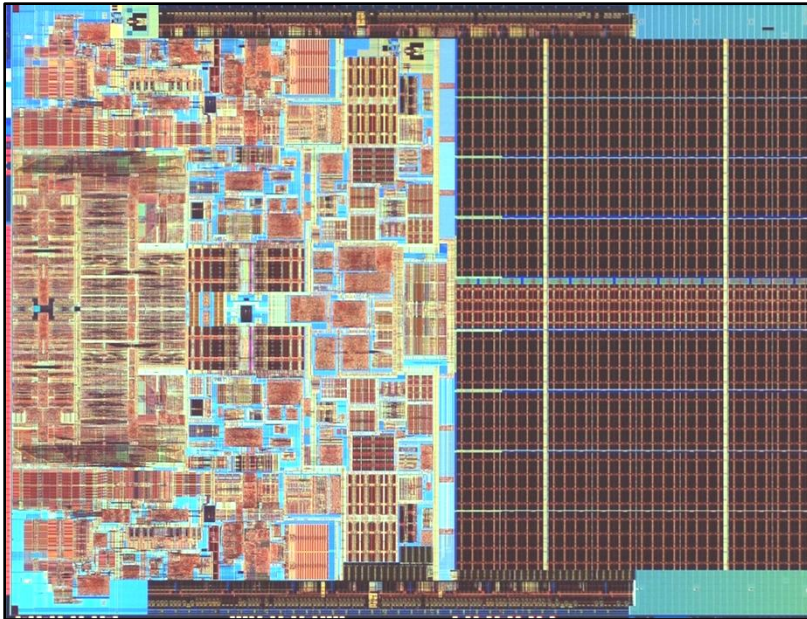


Cost per Transistor reducing by better than 0.7x per generation

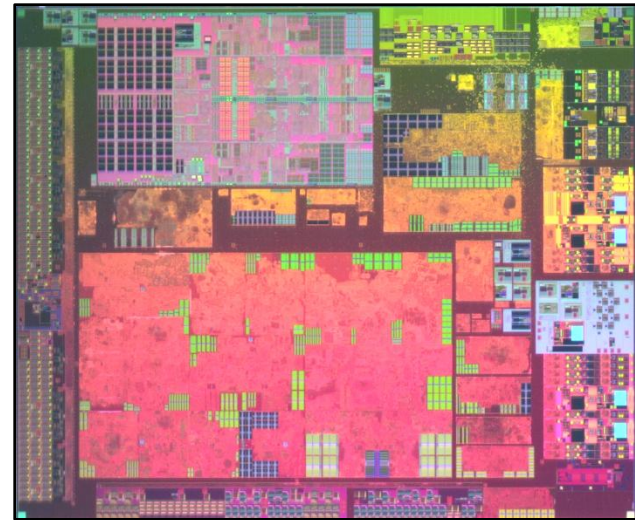
Source: Intel
* Forecast

Product Market Changes

65 nm CPU
(2005)

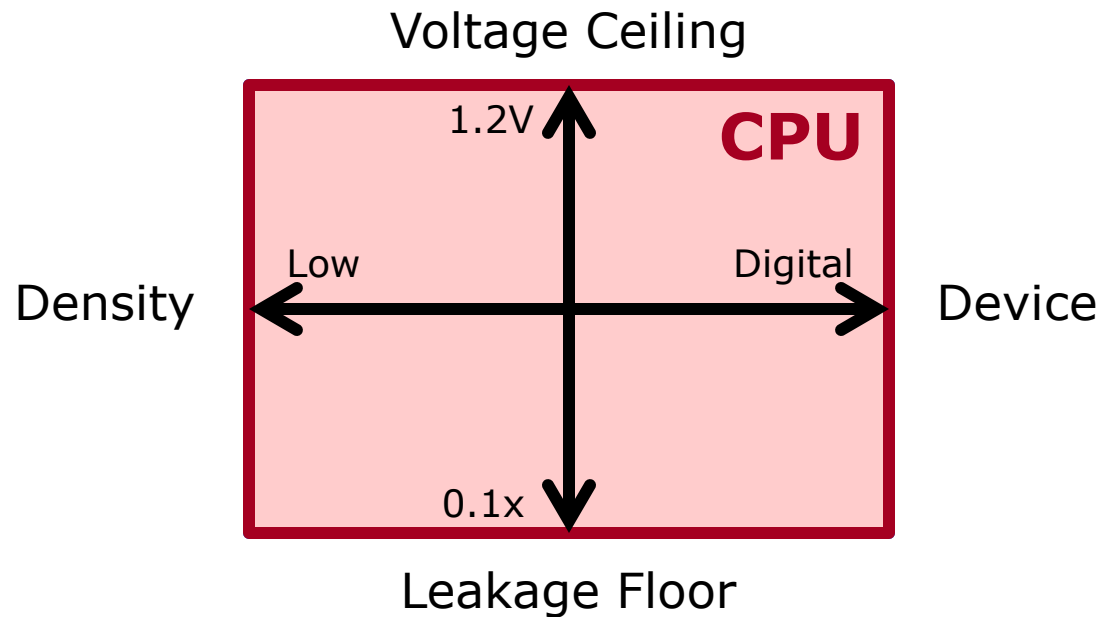


22 nm SoC
(2013)

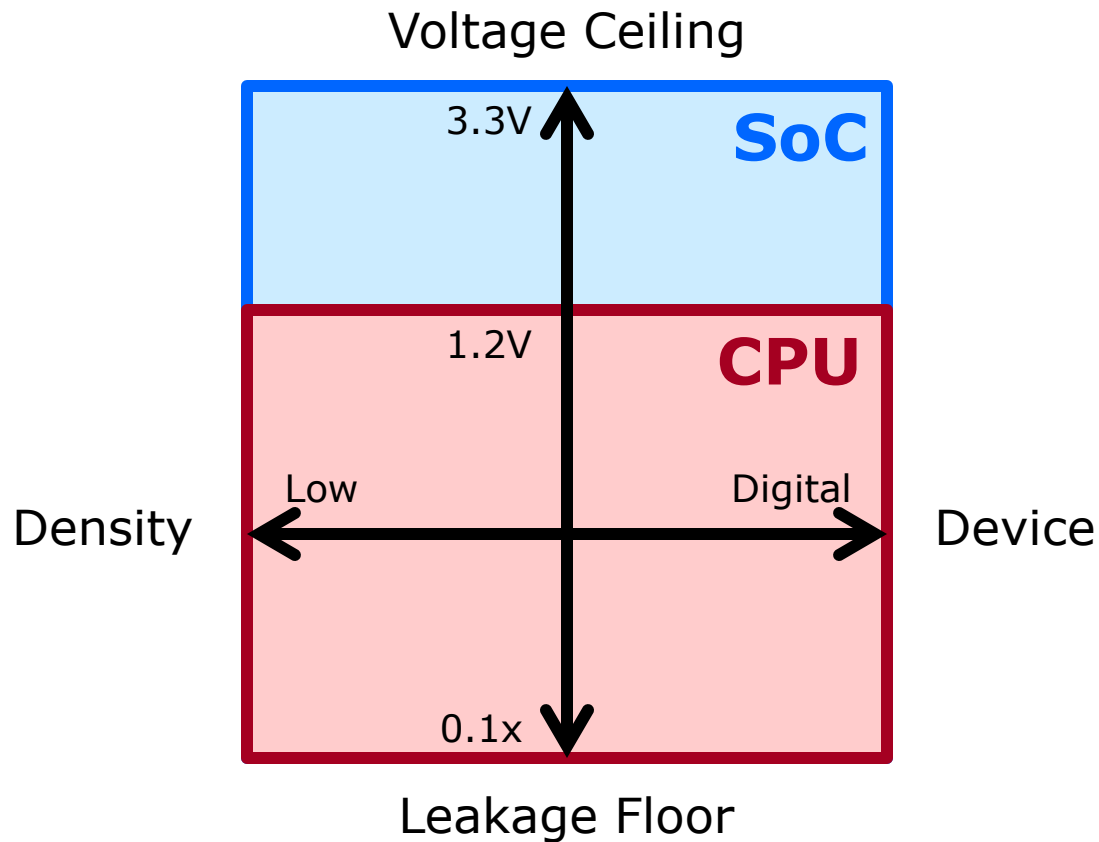


SoC products integrate a wider range of circuit and device types

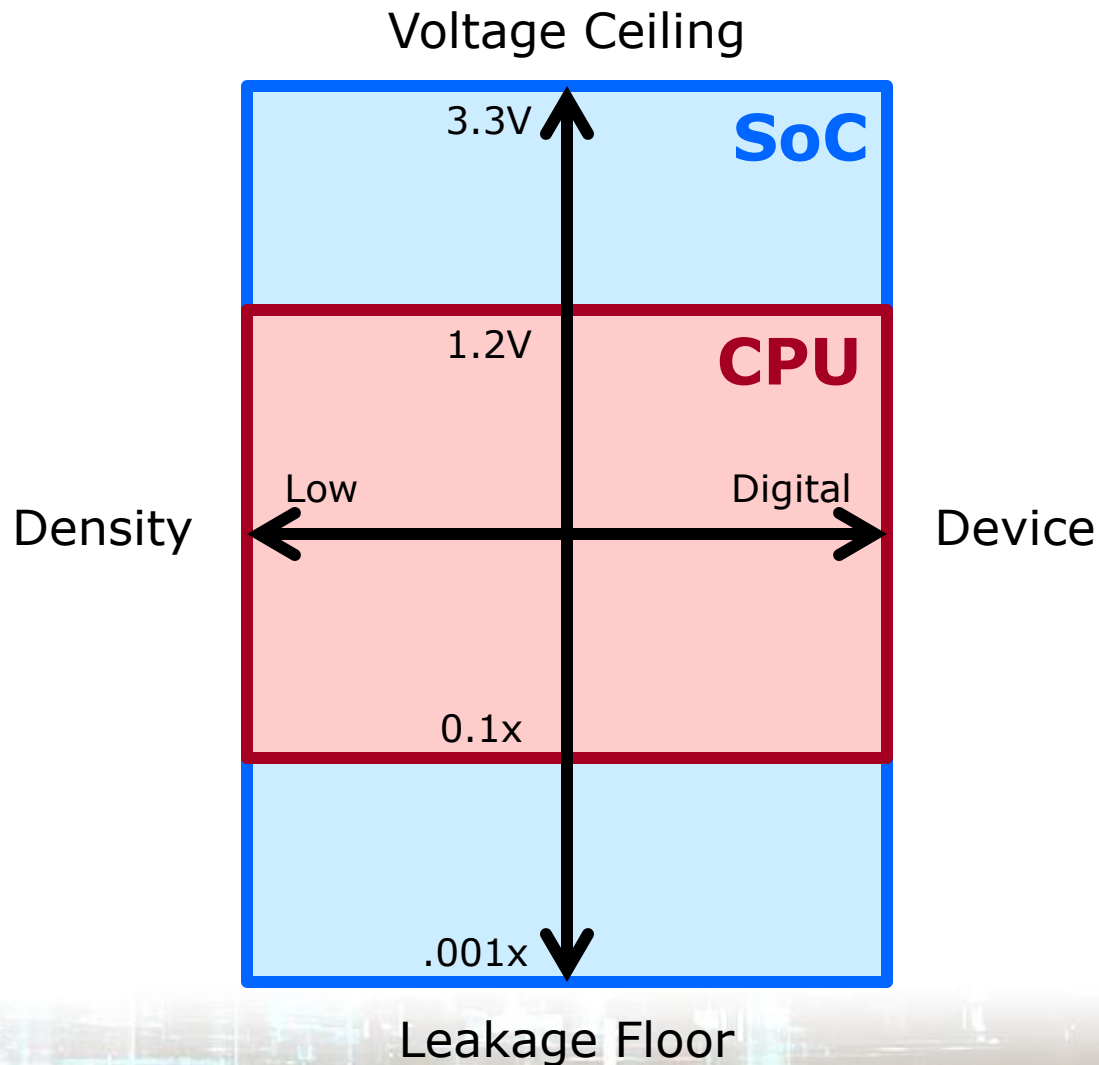
Expanding the Technology Envelope



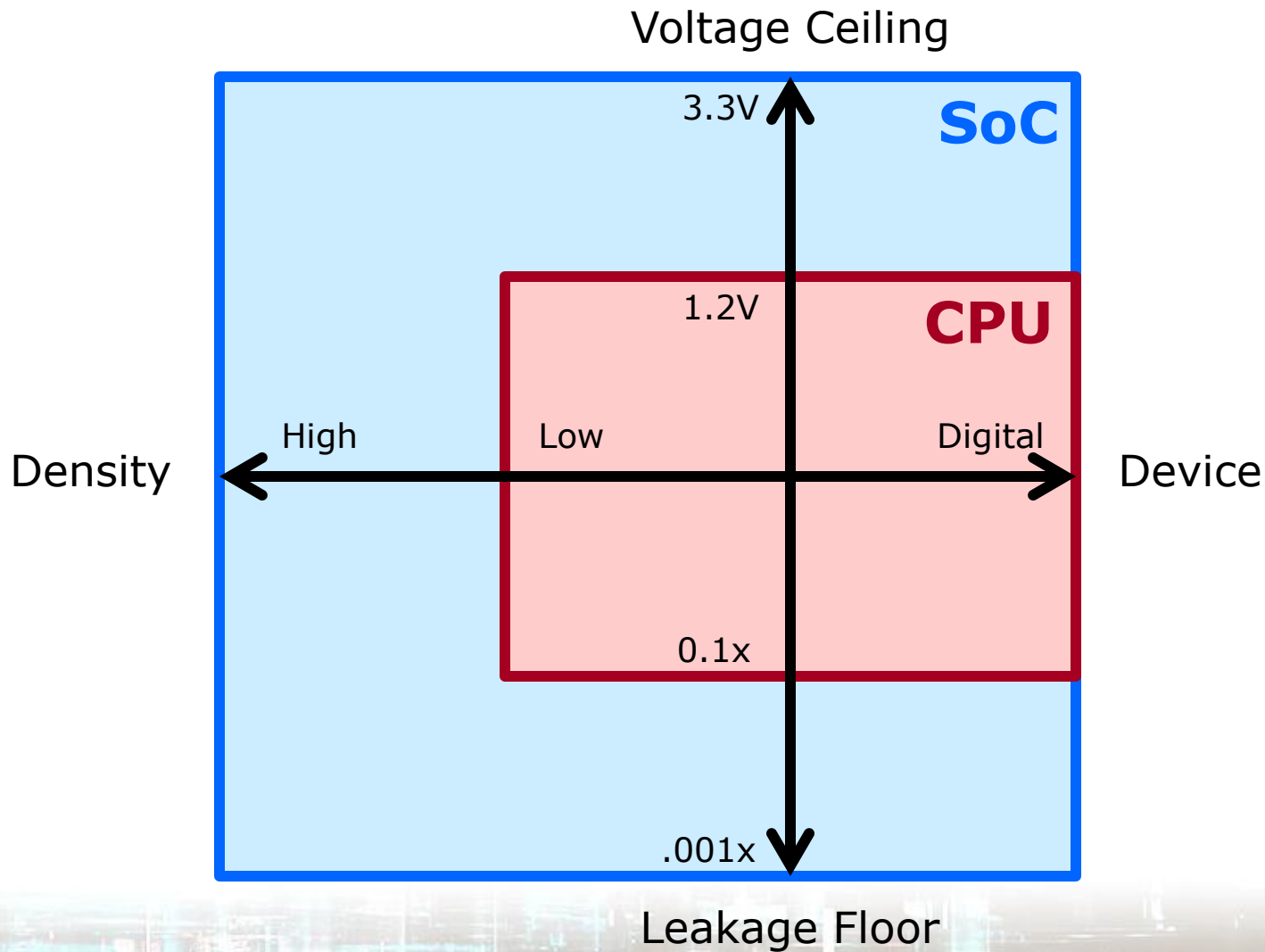
Expanding the Technology Envelope



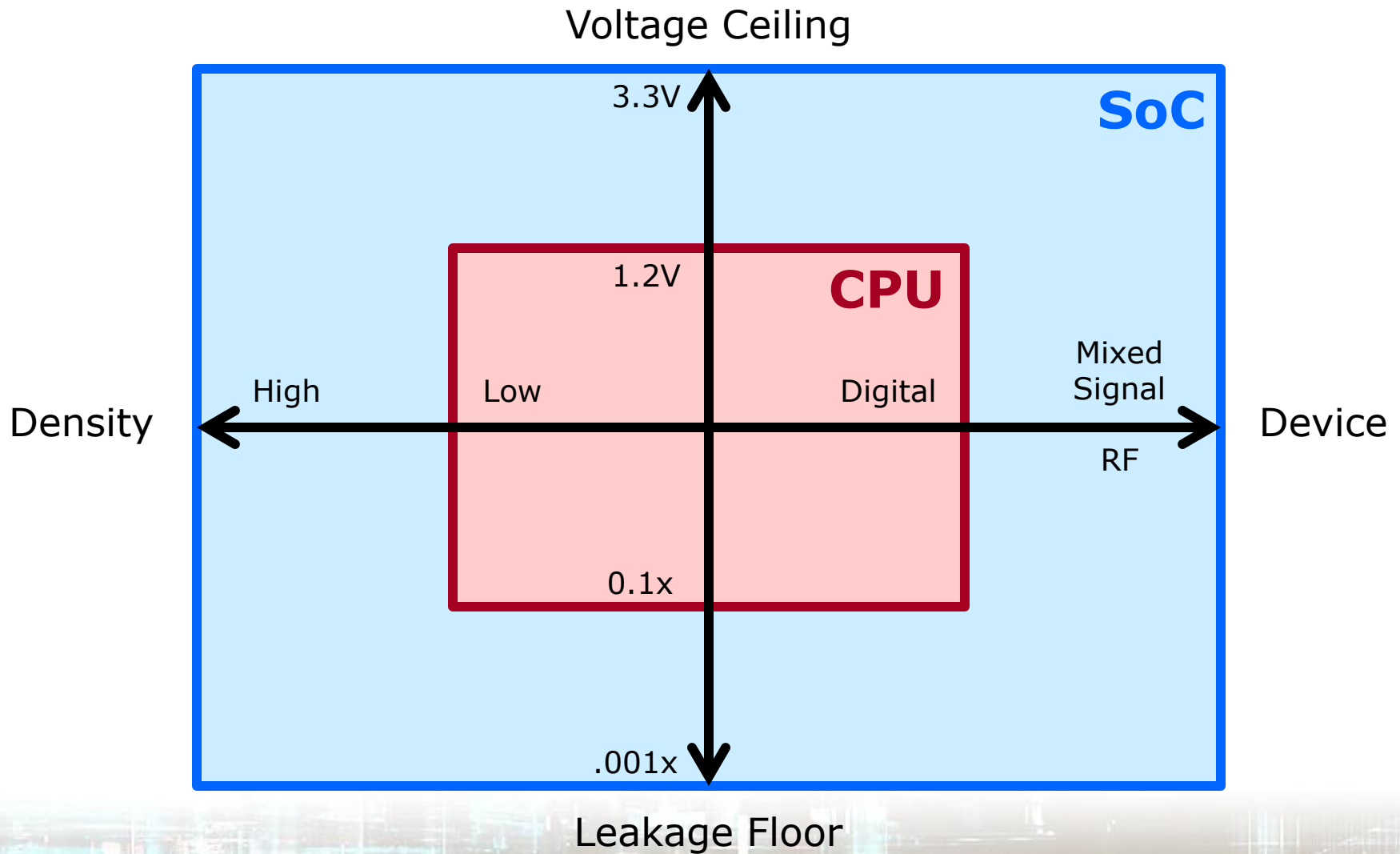
Expanding the Technology Envelope



Expanding the Technology Envelope



Expanding the Technology Envelope

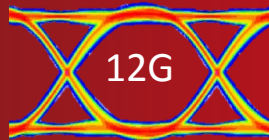


Intel Custom Foundry High Speed SerDes IP

22 nm

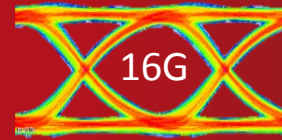
14 nm

General
Purpose



1-12G

Productized



1-16G

Test Silicon

High
Speed



19-28G

Productized

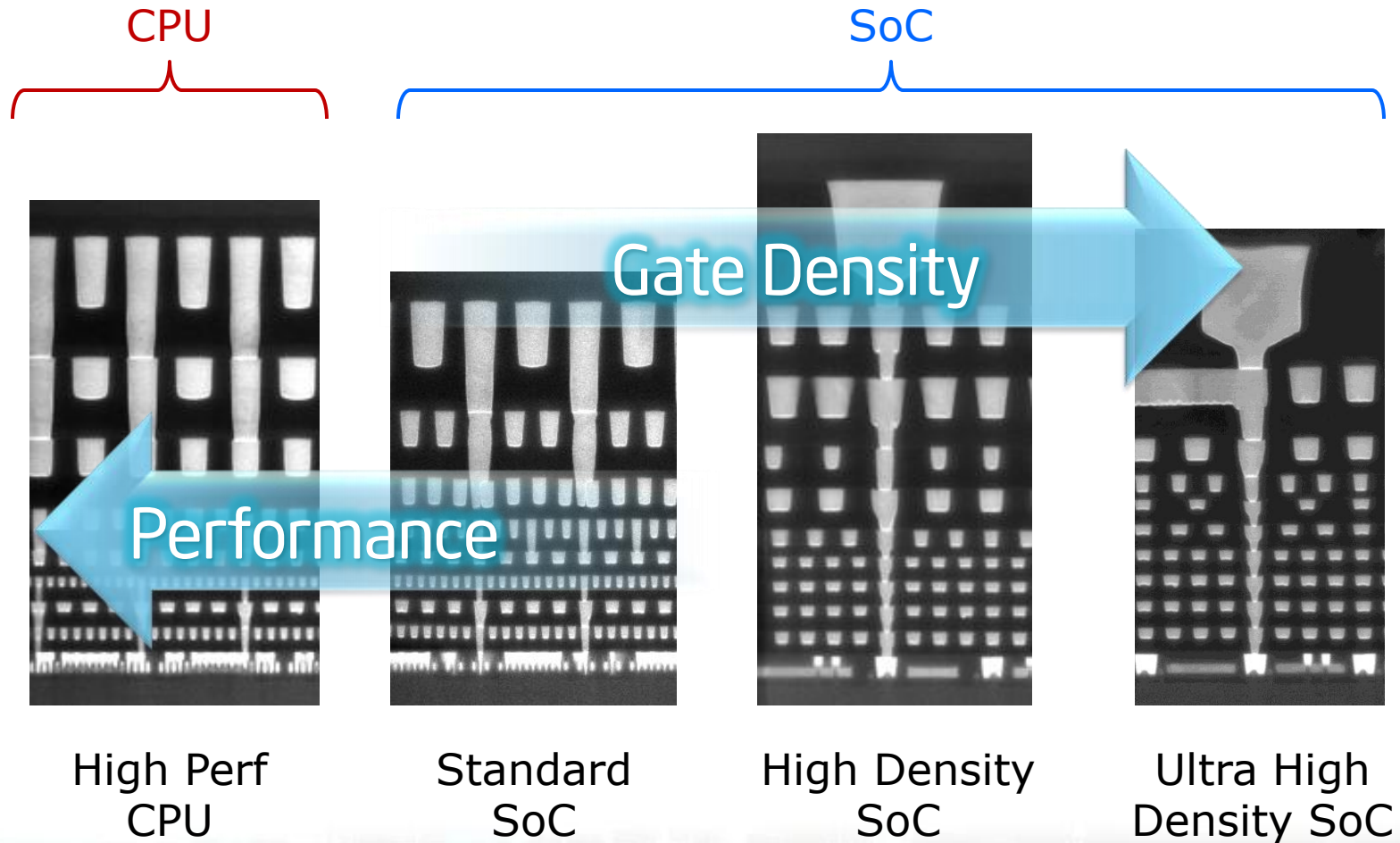
**Coming
Soon**

10-32G

Taped-Out

Industry leading power, performance, area
Intel Tri-gate transistors + leading edge architecture

Interconnect Options Enable Product Optimization

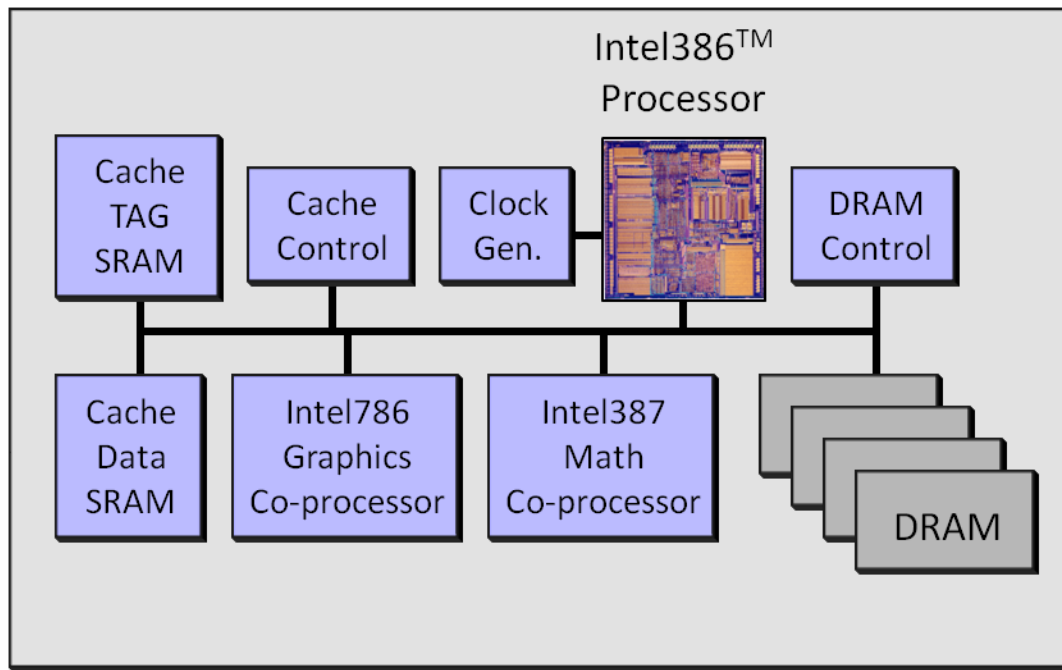


Expanding the Breadth of Technology Options

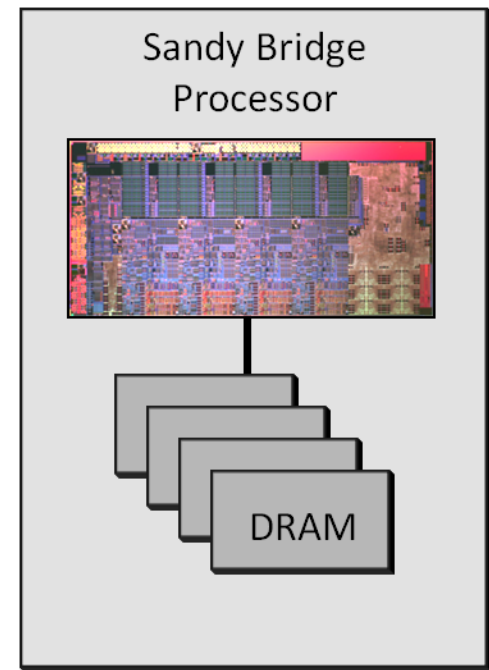
Features	Options	Client/ Server	Chipsets	Tablets	Embedded DRAM	Wireless Products	Smart Phones	Entry Mobile	FPGA/ ASIC
Logic Transistor	HP - High Perf. SP - Std. Perf/Pwr LP - Low Power	●	● ●	●	●	● ●	● ●	● ●	● ●
I/O Transistor	1.2V 1.8V 3.3V	●	●	●	●	● ●	● ●	●	● ●
Interconnect	RC Performance High Density Low Cost COB	●	●	●	●	●	●	●	●
Embedded Memory	e-SRAM - High Performance	●	●	●				●	●
	e-SRAM - Low Voltage	●	●	●				●	
	e-SRAM - Low Power		●			●	●		●
	e-SRAM - Dual Port		●	●	●	●	●	●	●
	e-PROM/OTP e-DRAM	●	●	●	● ●	● ●	● ●	● ●	● ●
Basic Analog/ Passives	Resistor - Linear	●	●	●	●	●	●	●	●
	Capacitor - MOS, MFC	●	●	●	●	●	●	●	●
	Capacitor - MIMCAP	●		●			●		●
	Inductor - Standard	●		●		●		●	●
Library	High Performance	●							●
	General Purpose	●	●	●	●		●	●	●
	High Density		●	●		●	●	●	●
Adv. Mixed Signals/ RF	Transistor - PA		●	●		● ● ● ● ●	●	●	●
	Resistor - Precision								
	Capacitor - Linear								
	Inductor - High Q								
	Deep Nwell/Triple Well								
	High Res Substrate								

System Integration

1985



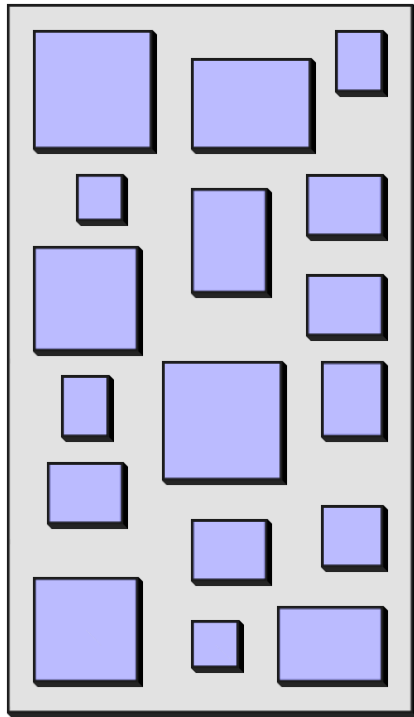
2011



Modern microprocessors integrate many of the separate system components from past platforms

System Integration

Cell Phone Platform



Processor

- CPU

Memory

- DRAM
- SRAM
- NAND Flash
- NOR Flash

Sensors

- 3-Axis Accelerometer
- 3-Axis Gyroscope
- Compass

Wireless

- Baseband Processor
- WiFi
- Bluetooth
- RF Transceiver
- RF Power Amp
- Tx/Rx Switch

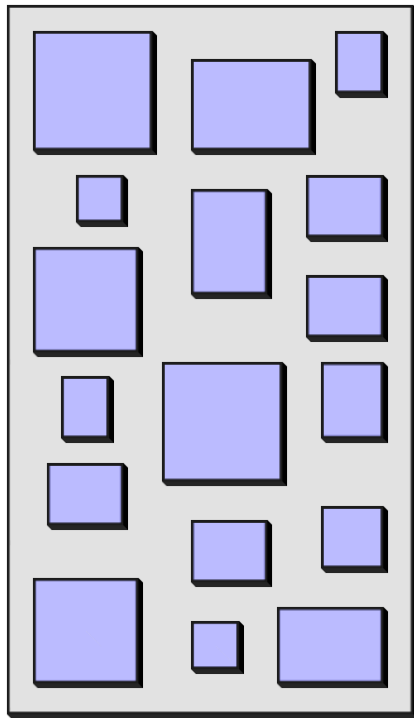
Misc

- Power Management Unit
- Audio CODEC
- Display Interface

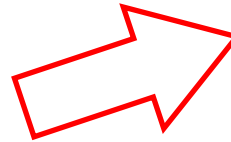
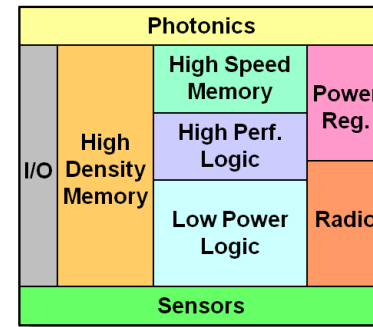
System integration opportunities in the mobile market

System Integration

Discrete ICs



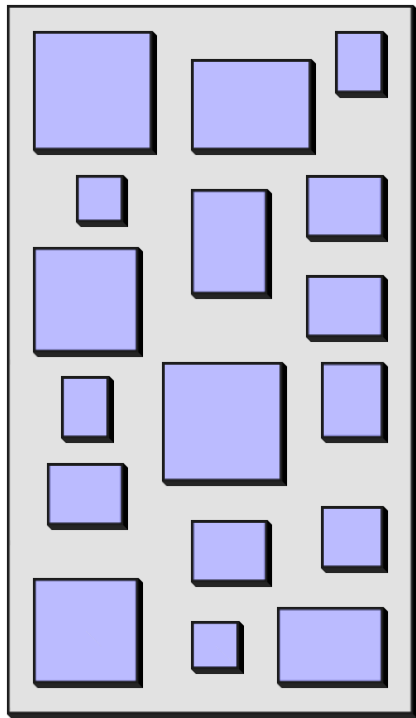
2-D Integration (SoC)



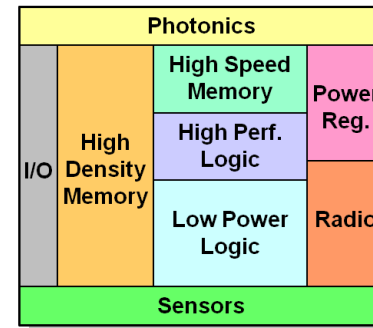
SoC provides smaller footprint and improved performance/power

System Integration

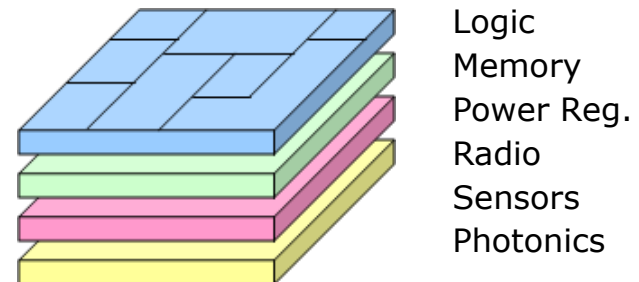
Discrete ICs



2-D Integration (SoC)



3-D Integration (SiP)



3-D integration is useful for combining disparate technologies
Unlike scaling, 3-D does not provide lower cost per transistor

Conclusion

- Scaling requires continued innovations in device materials and structures
- A highly coordinated research-development-manufacturing pipeline is needed to bring innovative technologies to volume manufacturing
- Intel's 14 nm generation provides a wide range of SoC features and delivers significant improvements in performance, power and cost per transistor
- The 10 nm generation is projected to continue to provide similar benefits

Conclusion

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- A highly coordinated research-development-manufacturing pipeline is needed to bring innovative technologies to volume manufacturing
- Intel's 14 nm generation provides a wide range of SoC features and delivers significant improvements in performance, power and cost per transistor
- The 10 nm generation is projected to continue to provide similar benefits

Moore's Law is indeed alive and well!